Report from HERA

58th Physics Research Committee Meeting at DESY

October 28, 2004

F. Willeke, DESY

- Summary of the 2004 Proton Positron Luminosity Run
- Shutdown Activities and Improvement Program
- Electron Proton Operation
- Schedule

Parameters of the 2004 HERA Luminosity Run

	Positrons	Protons
Beam Energy E /GeV	27.5	920
Beam Current I/mA	25-50	60-100
Number of bunches	126-180	120-180
Horizontal Beam Emittance ε_x/nm	20 → 27	5.1 → 5.6
Vertical Beam Emittance ε_y/nm	3.5	5.1 → 5.6
Horizontal β-Function at IP β_x/m	0.60	2.45
Vertical β-Function at IP β_y/m	0.26	0.18
Bunch length σ_p/m	0.09	0.20 → 0.24
Hour Glass Reduction Factor R	0.94 → 0.90	
Number of Colliding Bunches	114-174	
Specific Luminosity [10^{30} $mA^{-2}cm^{-2}s^{-1}$]	1.84 → 1.2-1.6	
Peak Luminosity [$10^{31}cm^{-2}s^{-1}$]	2.17 - 4.88 → 1.5-3.8	
Run Length [days]	211 → 139	
Goal of Accumulated Luminosity, [pb^{-1}]	150 → 87	

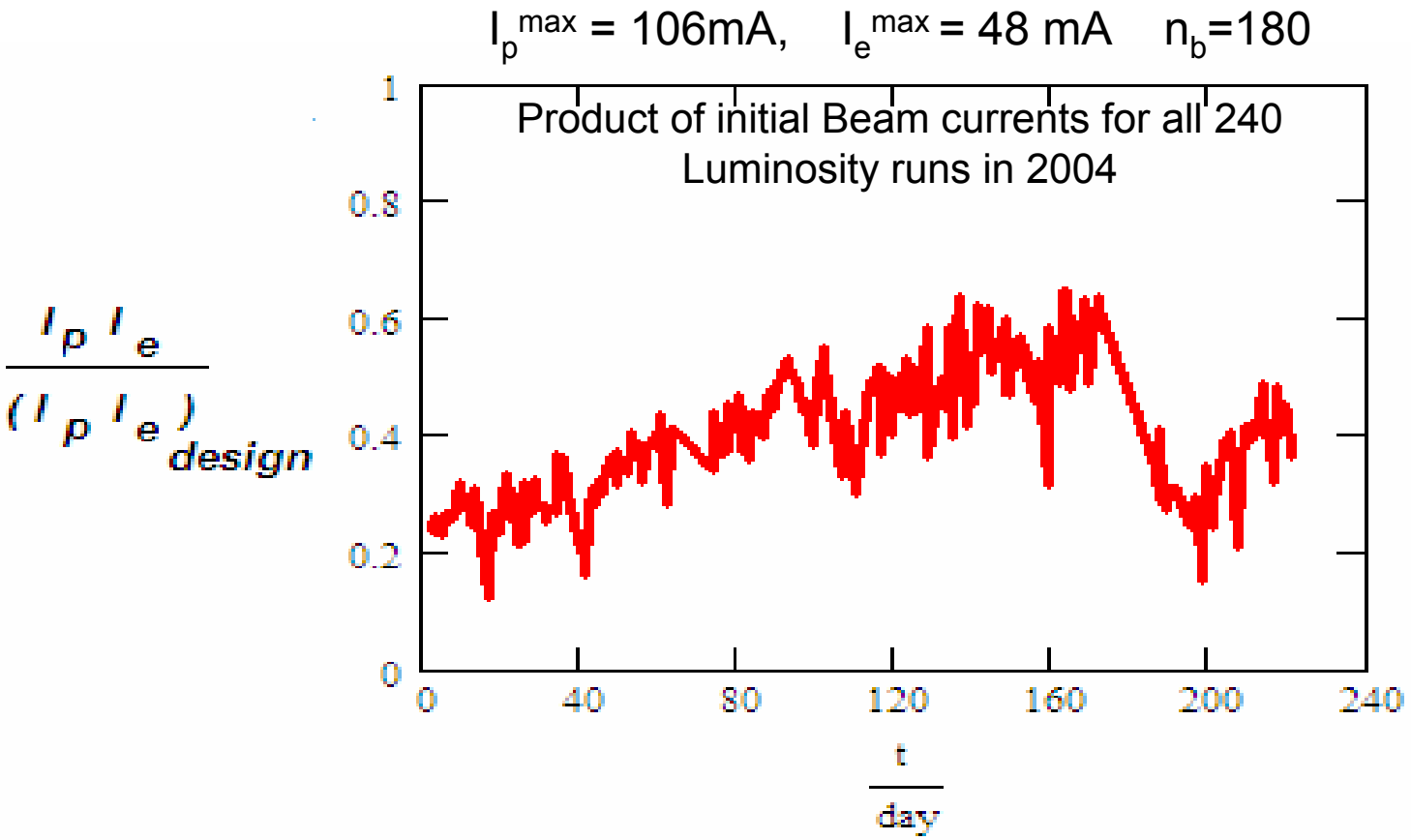
Beam-beam effects

Longitudinal instabilities

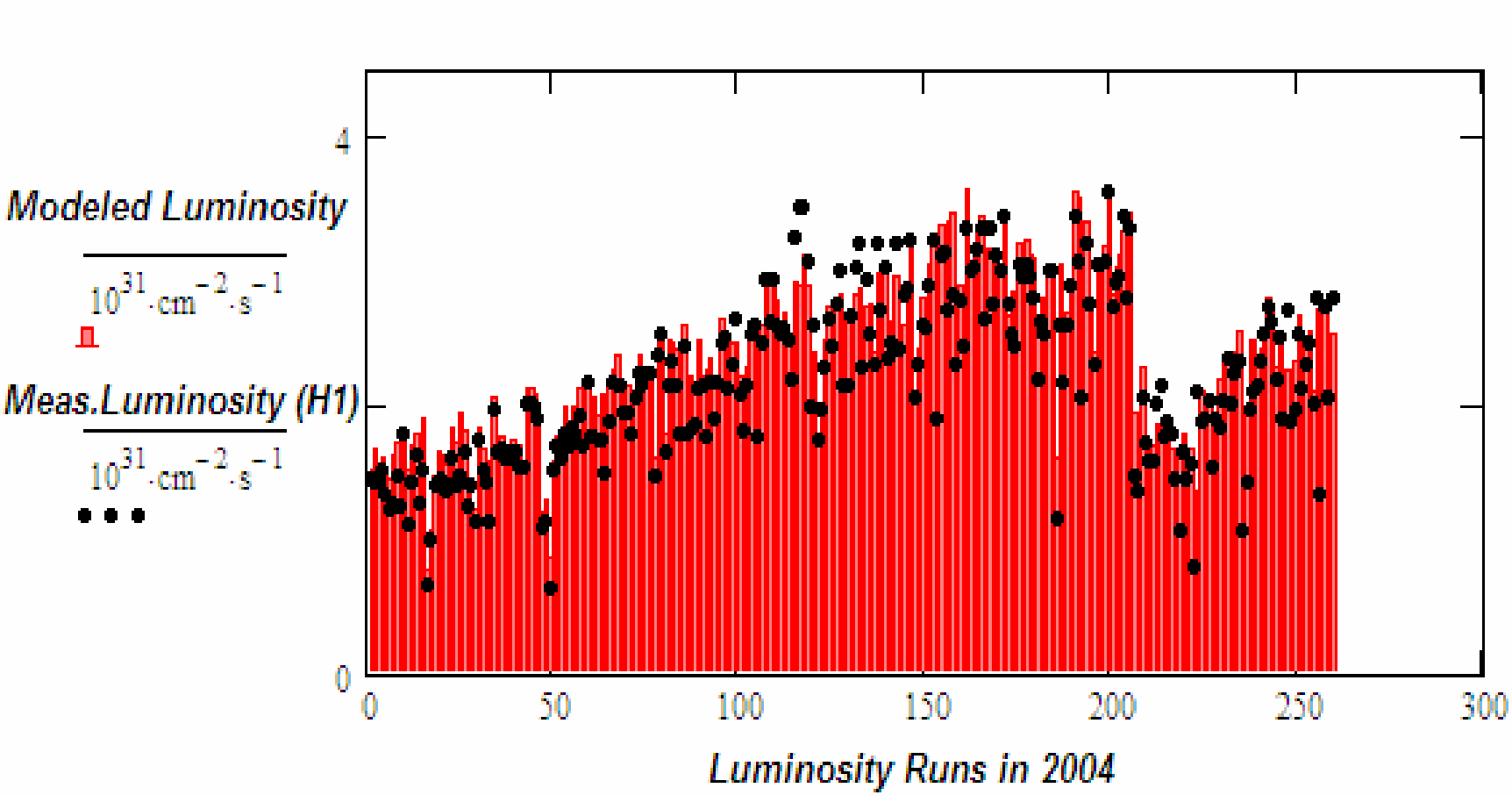
Major technical problems

HERA Beam Currents in 2004

Since February 2004: No beam current limitations due to experimental backgrounds: Beam currents raised as planned to Y 2000 level reaching ~60% of original HERA Design

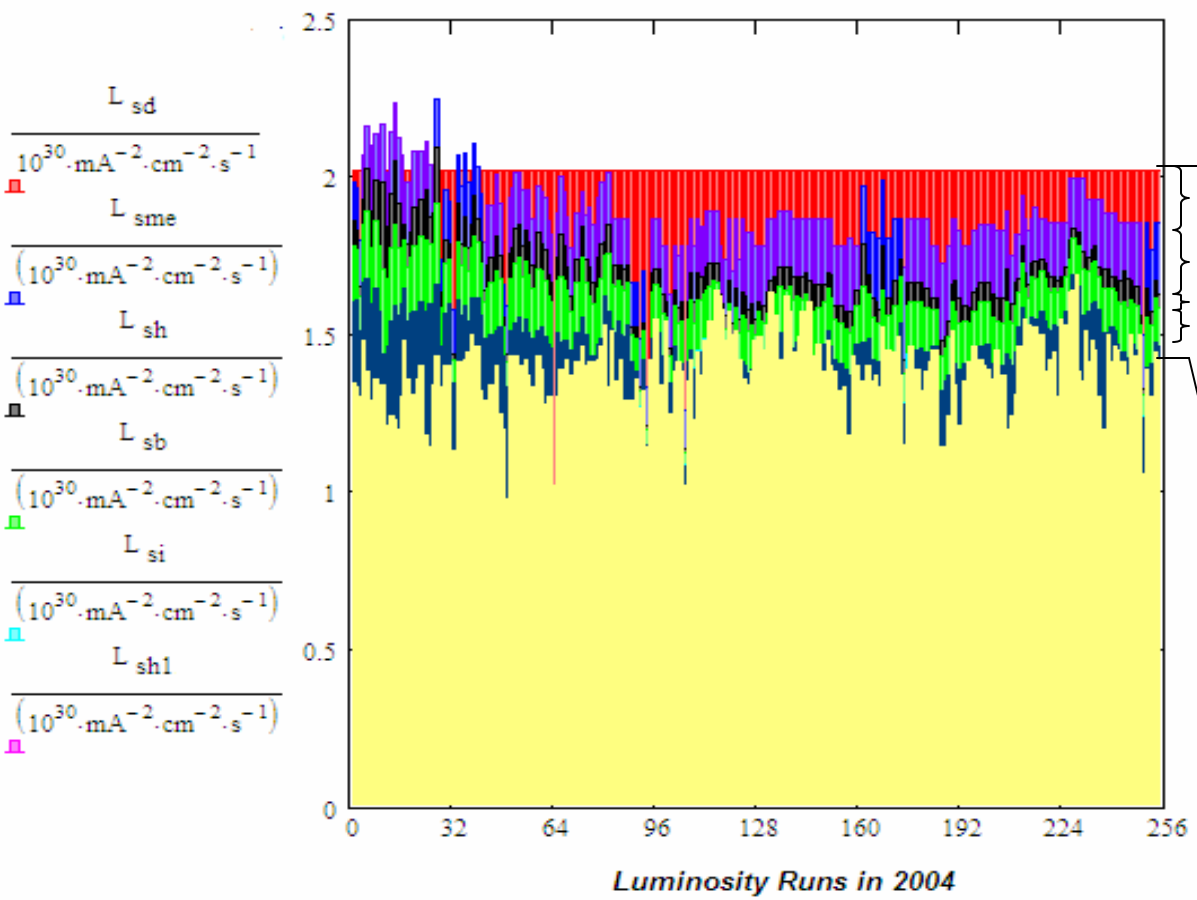


Peak Luminosity



F.Willeke: HERA, 58th PRC

Understanding of Specific Luminosity



Ideal Value

Taking into account:

Emittance increase -7%

Hour glass effect -8%

Residual beta beat -3%

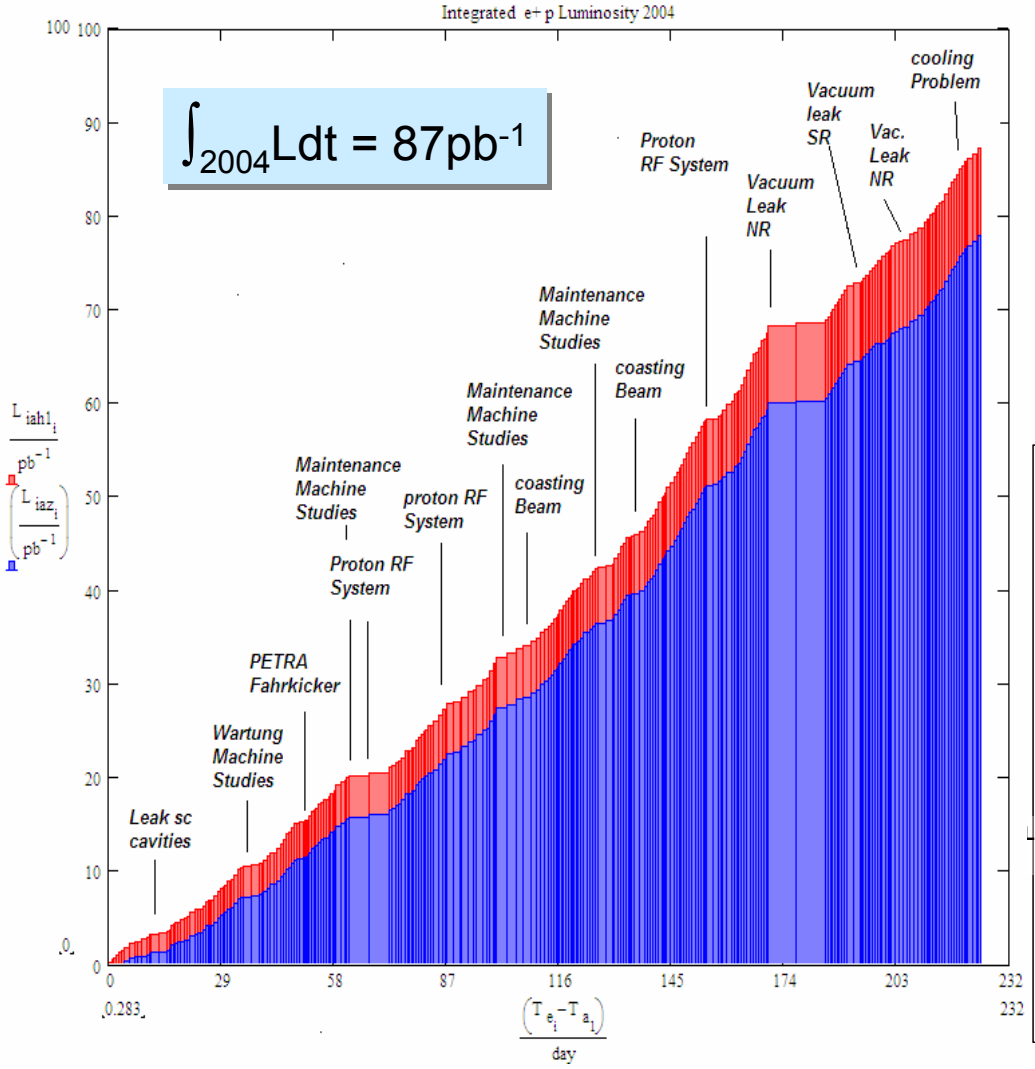
Synchro-betatron resonances -6%

Measured by H1 -24%

➔Specific luminosity reasonably close to expectations (75%)

short comings well understood, measured planned for further improvements

2004 Luminosity Accumulation

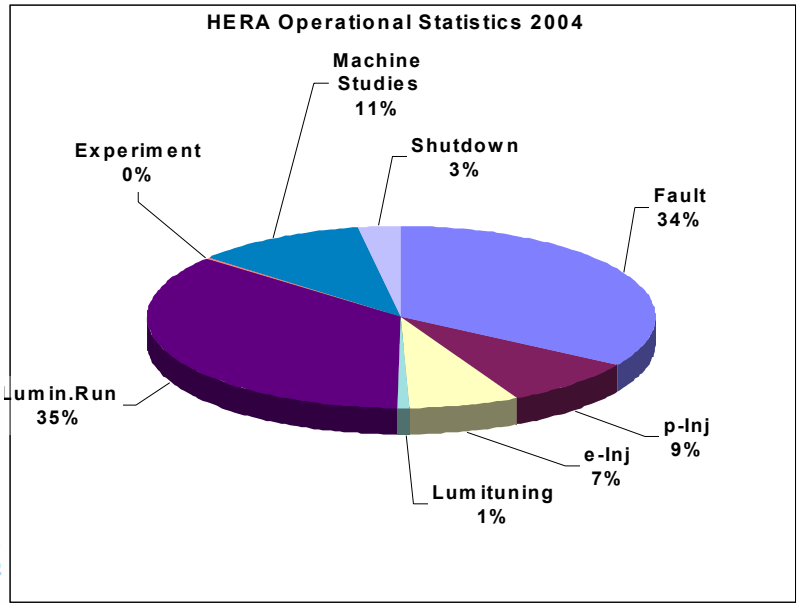


Peak luminosity➔ 1.2 $pb^{-1}d^{-1}$
Best week 0.9 $pb^{-1}d^{-1}$
2004 Average 0.4 $pb^{-1}d^{-1}$

~50 days of operations lost

Due to major technical failures ➔

Operational efficiency needs to be improved

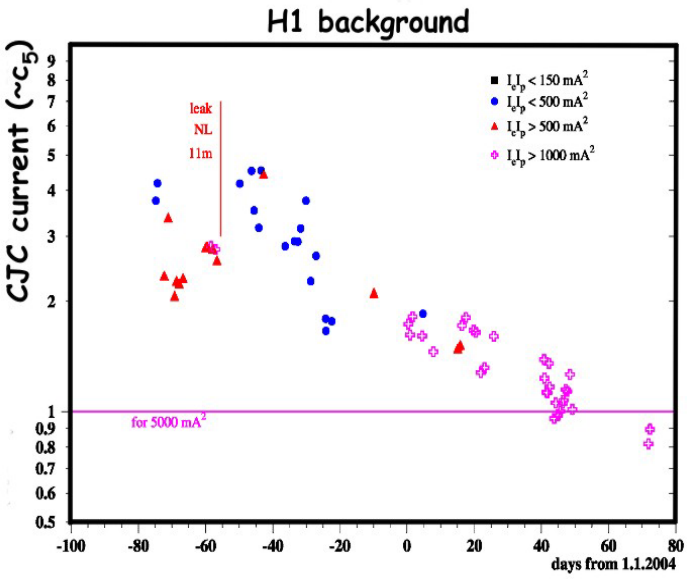


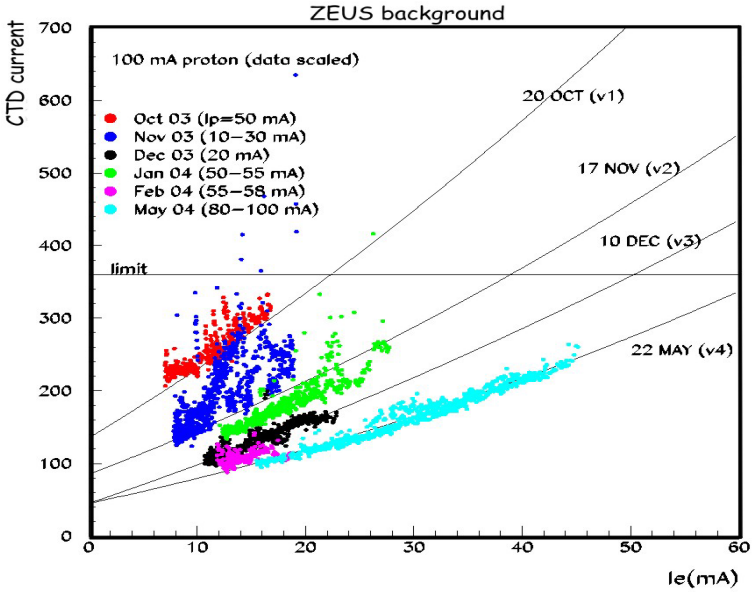
F.Willeke: HERA, 58th PRC

Detector Backgrounds

additional collimators far upstream of IPs
change in masking at ZEUS (critical)
additional pump near IP at H1 (in wind shadow of 2003 shutdown
increased conductance of pumping ports
Warm up of sc magnets during scheduled maintenance
steady operations with high beam currents

recent status at the colliding beam experiments:



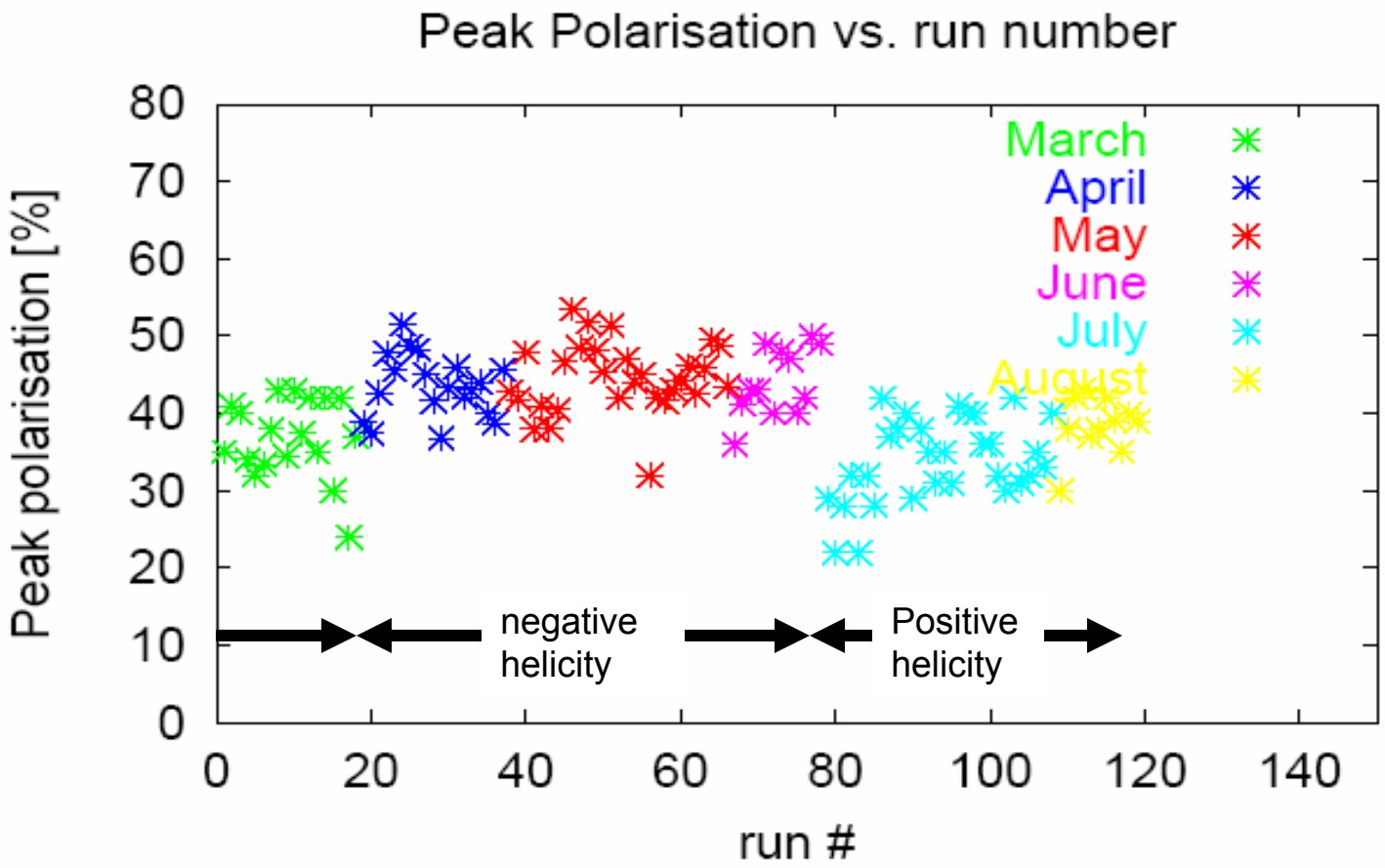


However: Background problems due to large coasting beam due to RF problem and after a vacuum leak NR

Polarisation in the period March-August 2004

after turning to the nominal number of bunches

(only runs longer than 4 hours considered)



Issues and Measures

Issues	Measures	Planned for
• Large Beam pipe Temperatures NR/SR11m,14m,19m	New Beam pipe 19mNR New Absorber 4 NR	This shut down, done
• Frequent Vacuum leaks SR/NR11m	Welded pipe pipe connection replaces weak flanges	This shut down, done
• Overheating GI SR/NR Beam pipe	Improved Temperature survey Restauration of Absorber 2	This shut down done
• Vacuum leaks at rotator	Improved bellow design	Done
• Coasting Beam Generation	Improved RF Monitoring	This shut down, tests in progress
• Operational inefficiencies	Enhanced Automation Improved Operator training	In progress
• Loss of luminosity due to large proton bunch length	Longitudinal Damper	Project started
• Proton RF system Failures	Increase Human Resources	Jan 05
• Frequent Ground faults of BU coils	Refurbish BU Magnets	This shutdown, next shut down

Coil Refurbishing Vertical n.c. BU Dipole Magnet in HERA p

- Needed to bend proton beam upwards at both ends of the IR
- There are 3 Magnets on both sides of the IP in the three IR-s

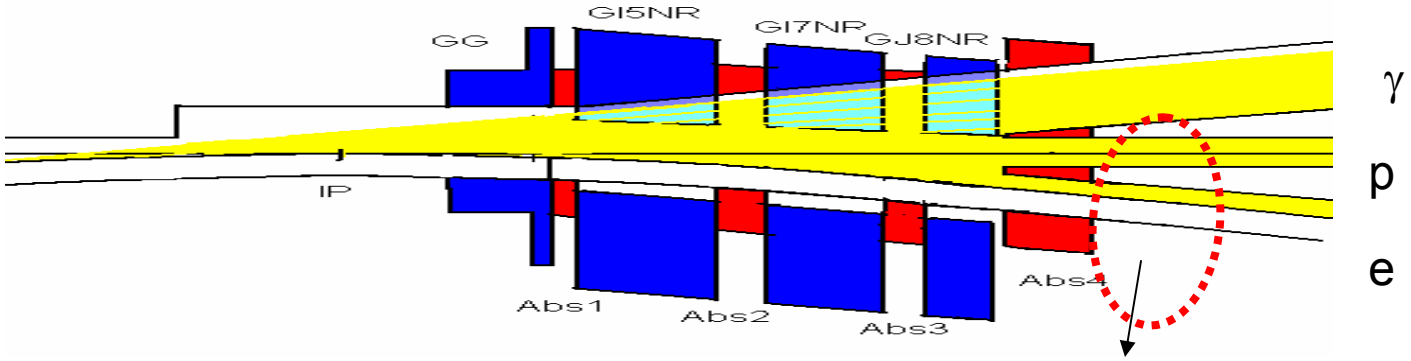
= 18Magnets

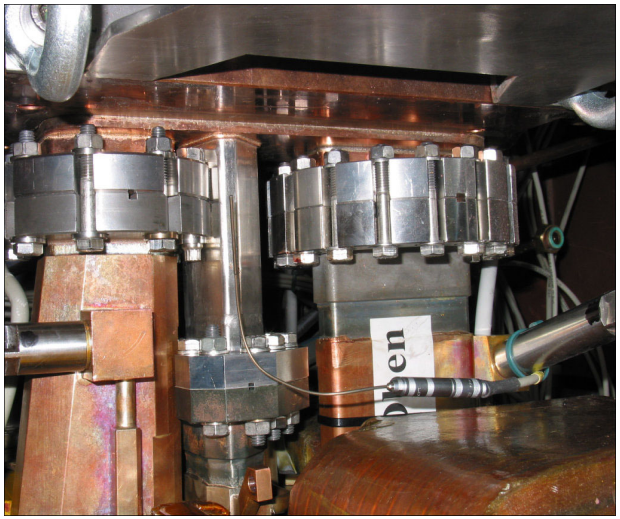
- Magnets develop ground faults because of water leaks of the brazed Cu conductor
- All coils tested so far ~8 have leaks

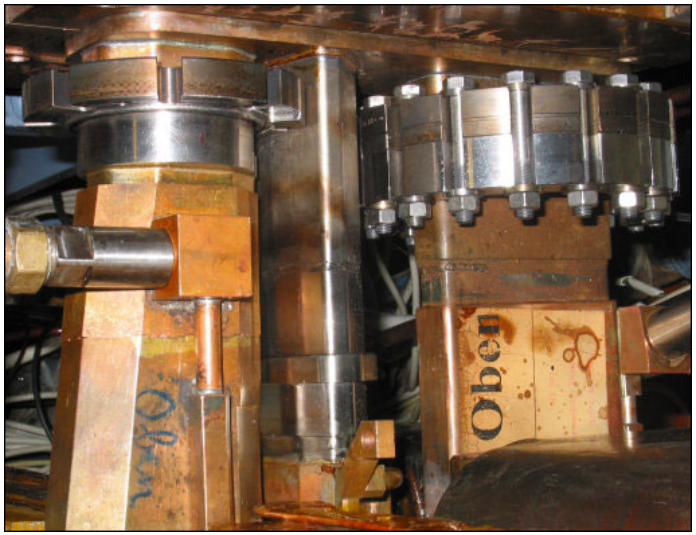
➔

- Refurbishing program
- This shutdown: 6 Half coils NL replaced
- 8 more coils ordered for later replacements

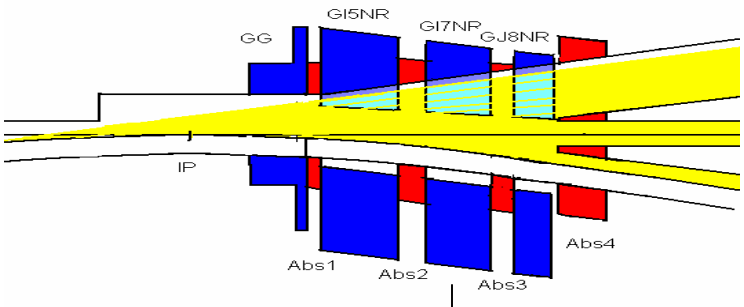
Troublesome Flange Connection NR Replaced by Welded Connection

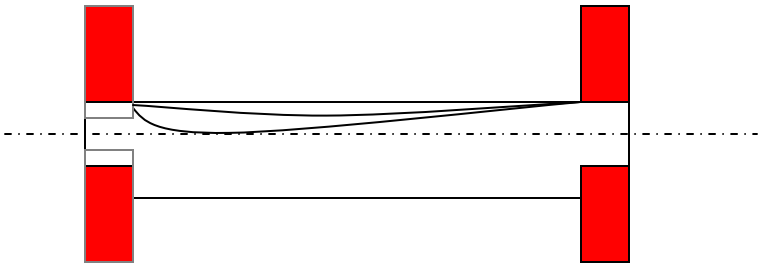


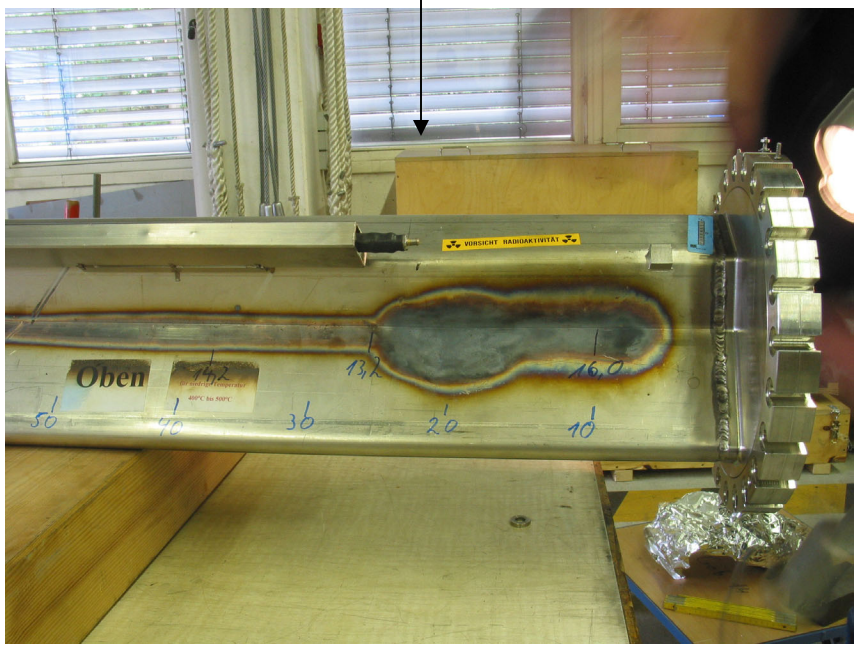




Pipe of GI NR7m hit by direct Synchrotron Radiation







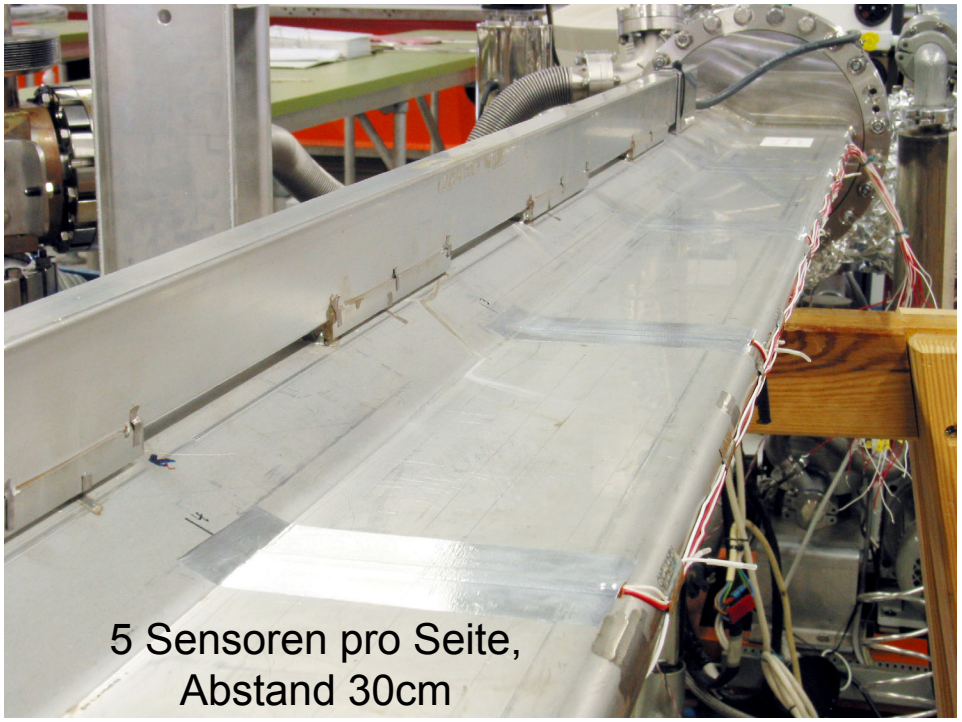
Measures:

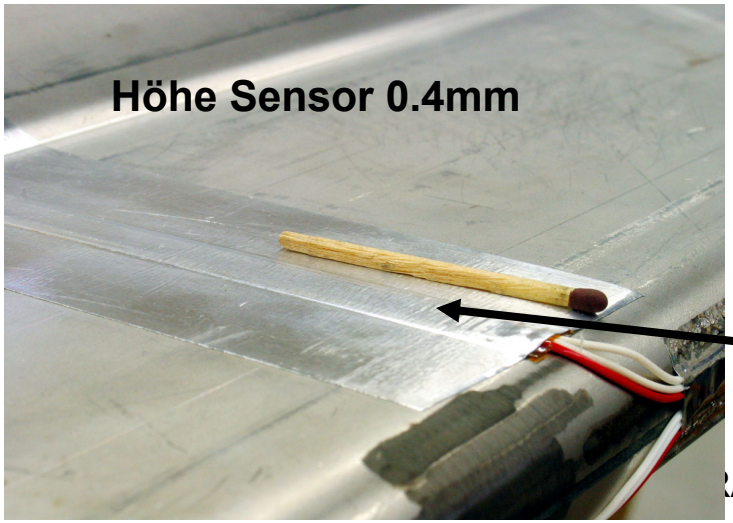
Restauration of absorbers 2
➔ planned to be installed 2005

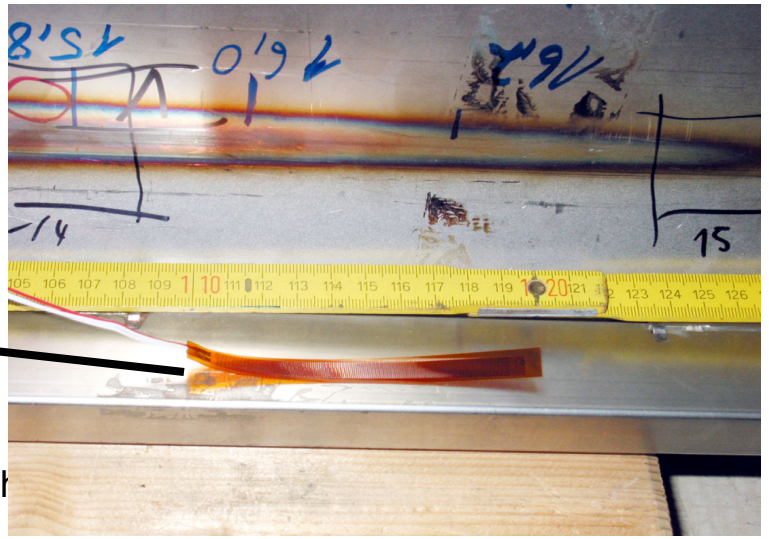
Improved Temperature survey
➔ implemented

Improved

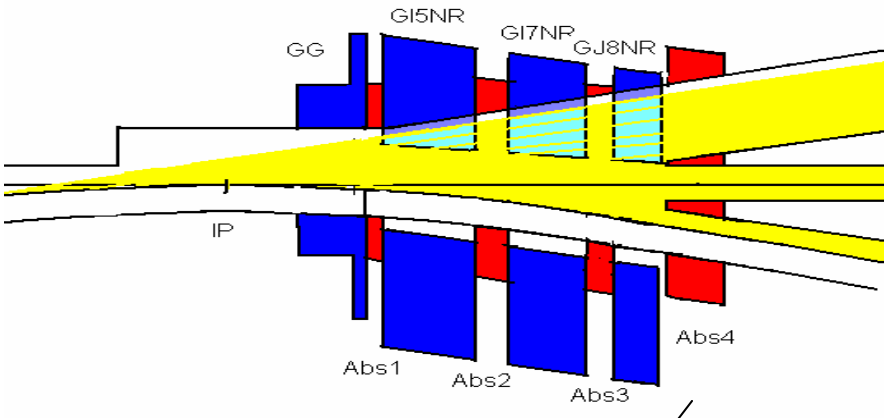
Temperature survey

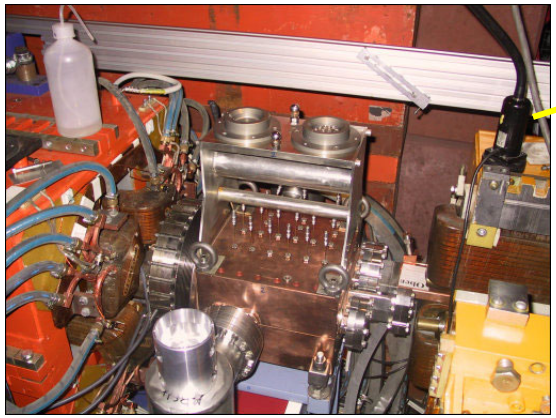


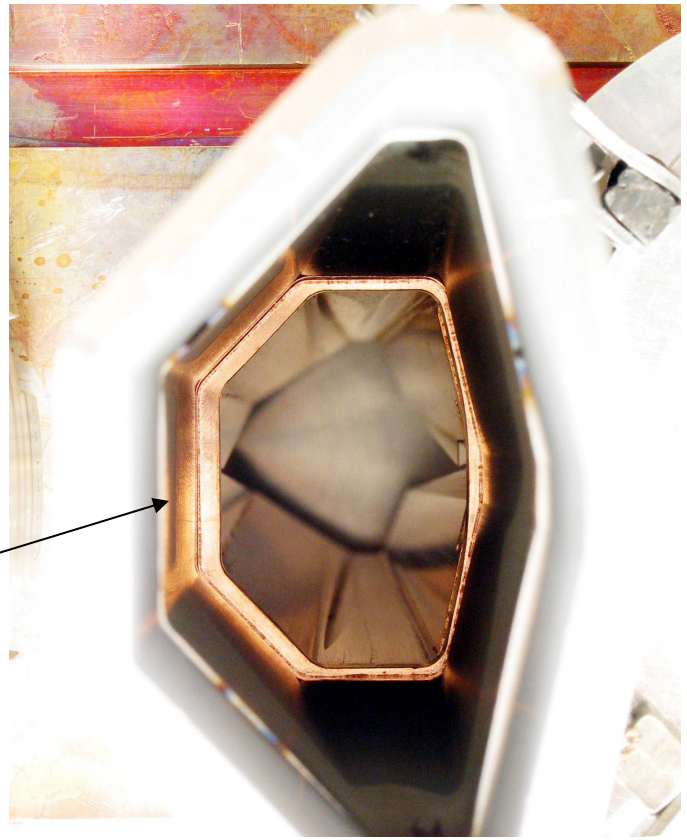




Improved Absorber 4 NR11m:

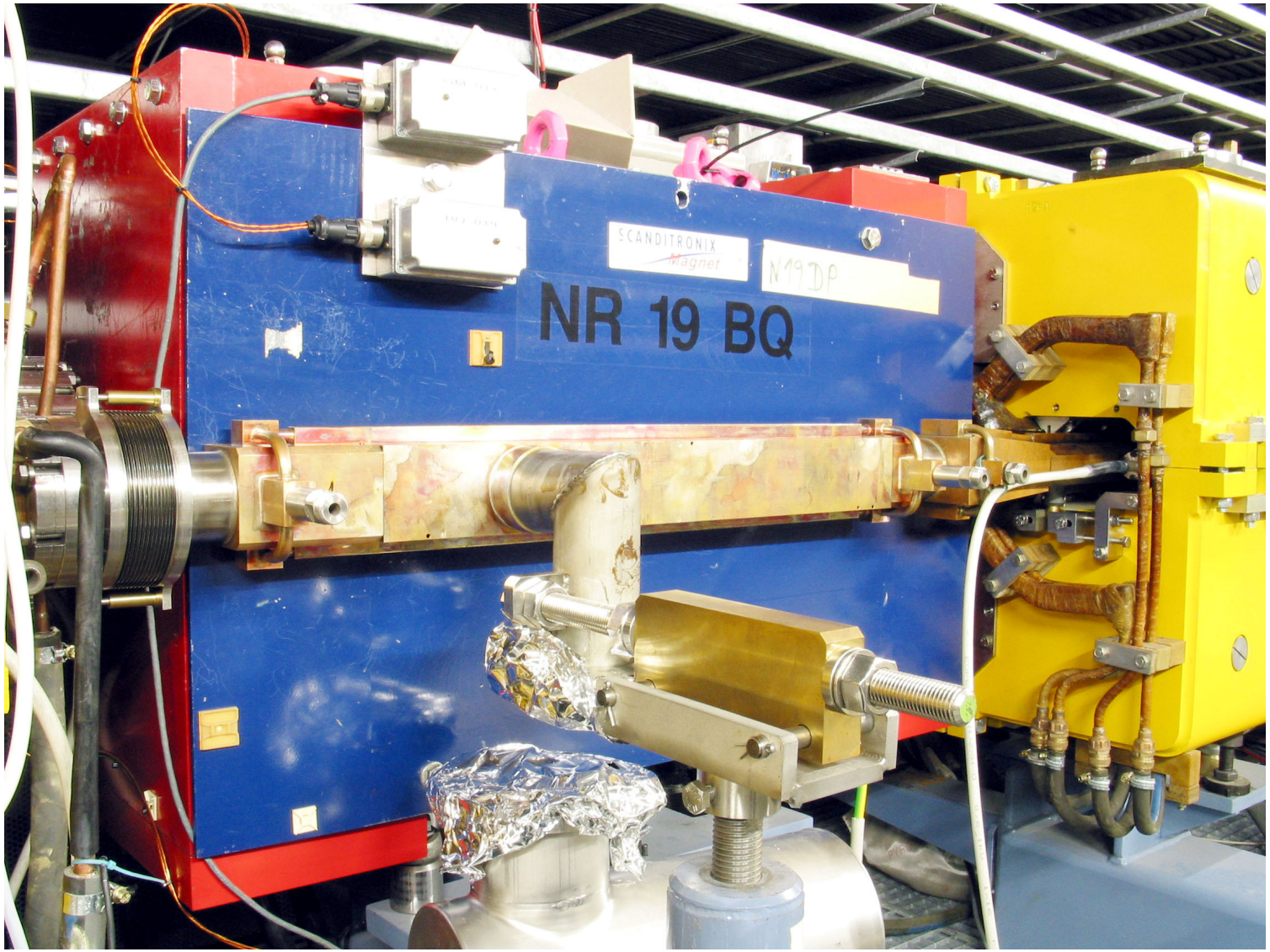




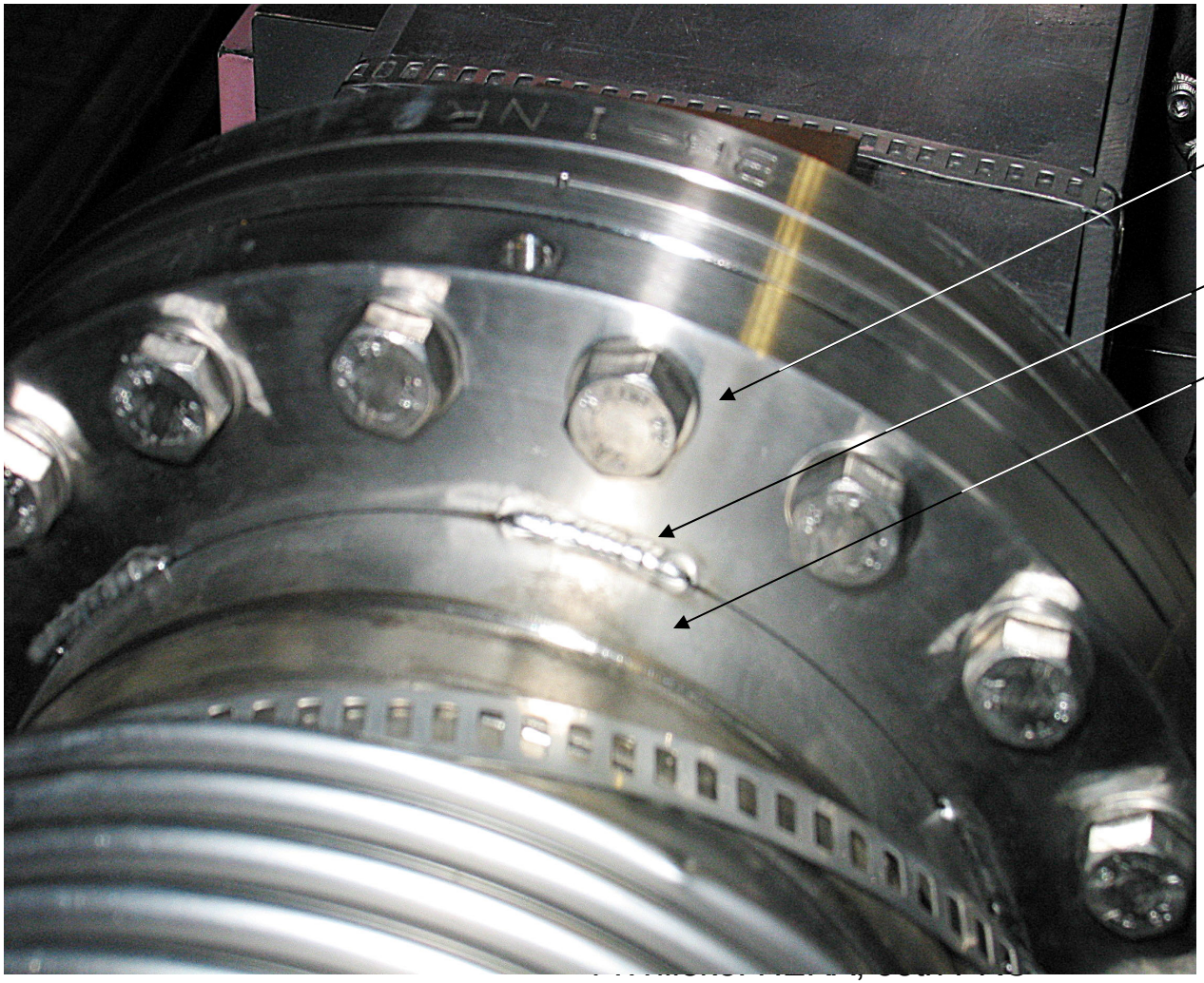


Status: eingebaut

Improved cooling NR19m eRing



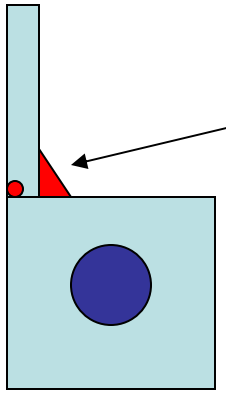
Shielded Bellow Rotator NR/SR- Support Welds



Bordscheibe
Conflat Flansch

Neue Stützнähte

Wassergekühlter
Edelstahlabsorber



electron-proton collisions

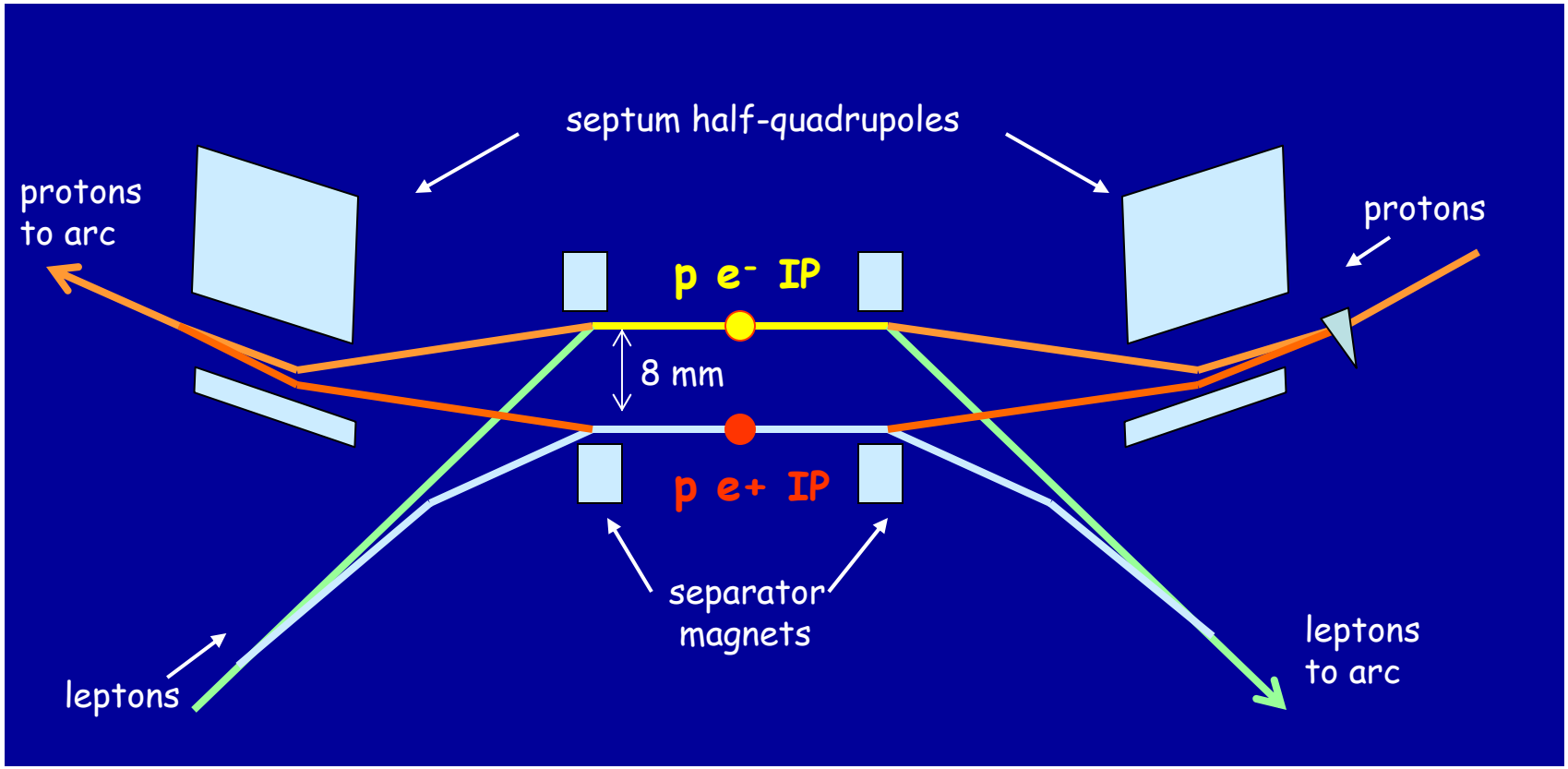
radial shift in IP by 8mm required

Orbits in IP will be different for

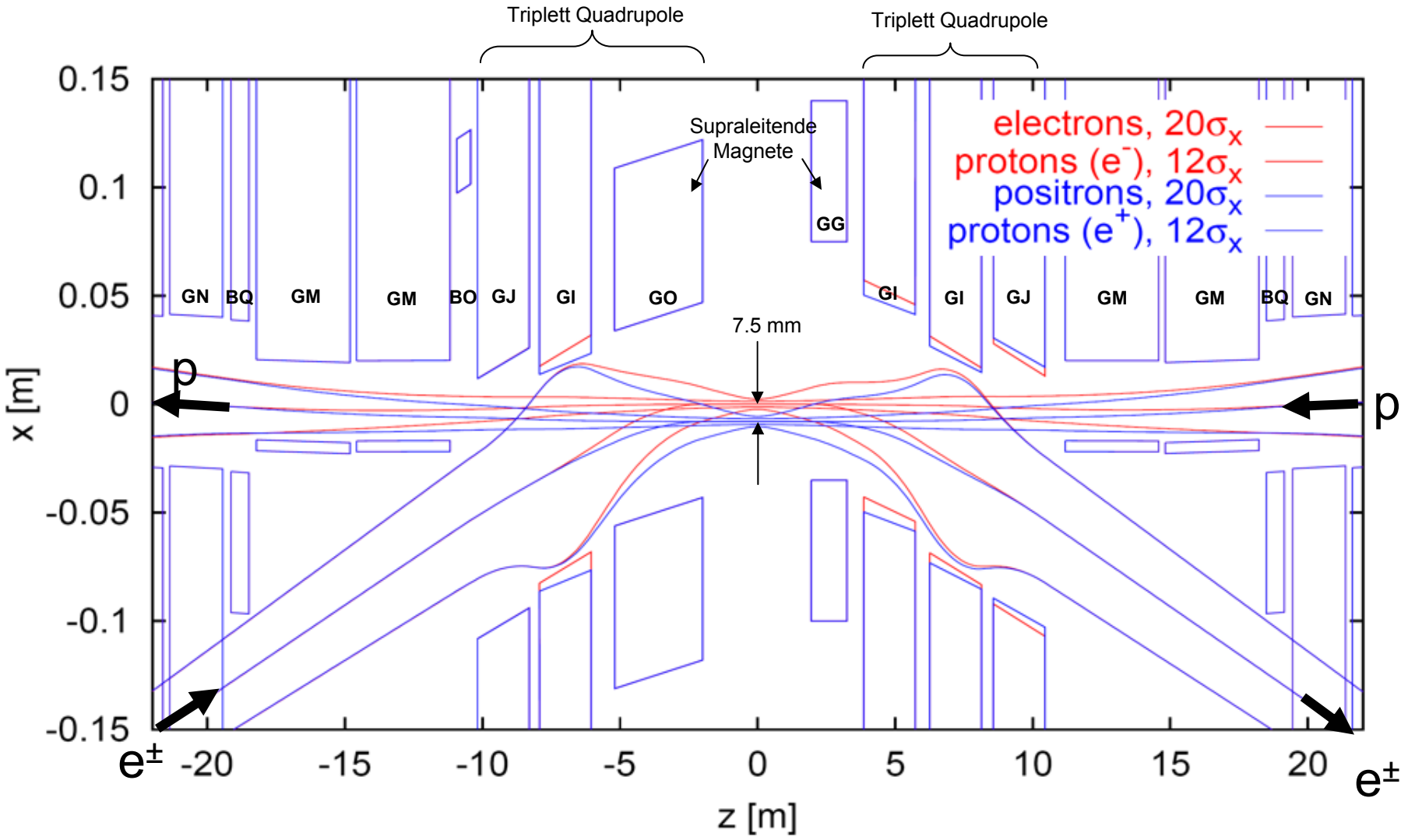
p - e^- collisions

p - e^+ collisions

(to save the space that would be necessary for additional magnets for compensation of the change in orbital deflection angle with switched polarity



Electron Running:IR Geometry



F.Willeke: HERA, 58th PRC

Alternative IR Beam Orbits investigated

Horizontal SR-Fan @ C5a

Original-Design for Elektrons

Overlapping SR Fans of BO, GJ und GI NL/SL.

Disadvantage: Beam off axis GJ, GI NL/SL

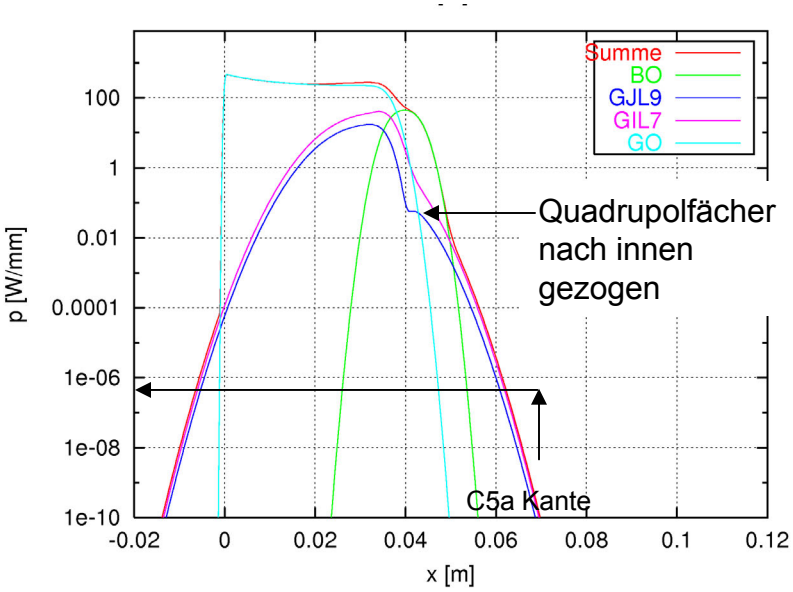
more SR Power of GO

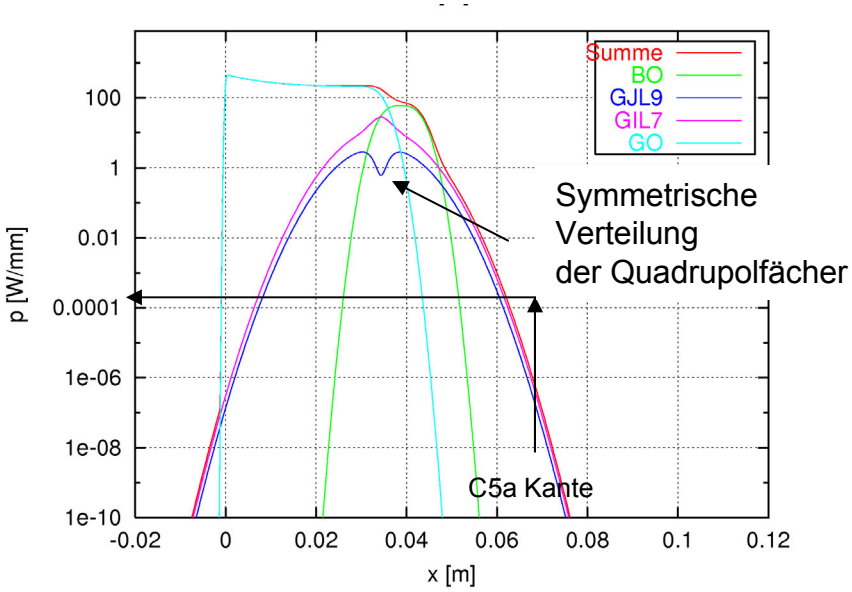
Alternative Design for Elektrons

Beam on axis GJ und GI

10% less GO-SR power

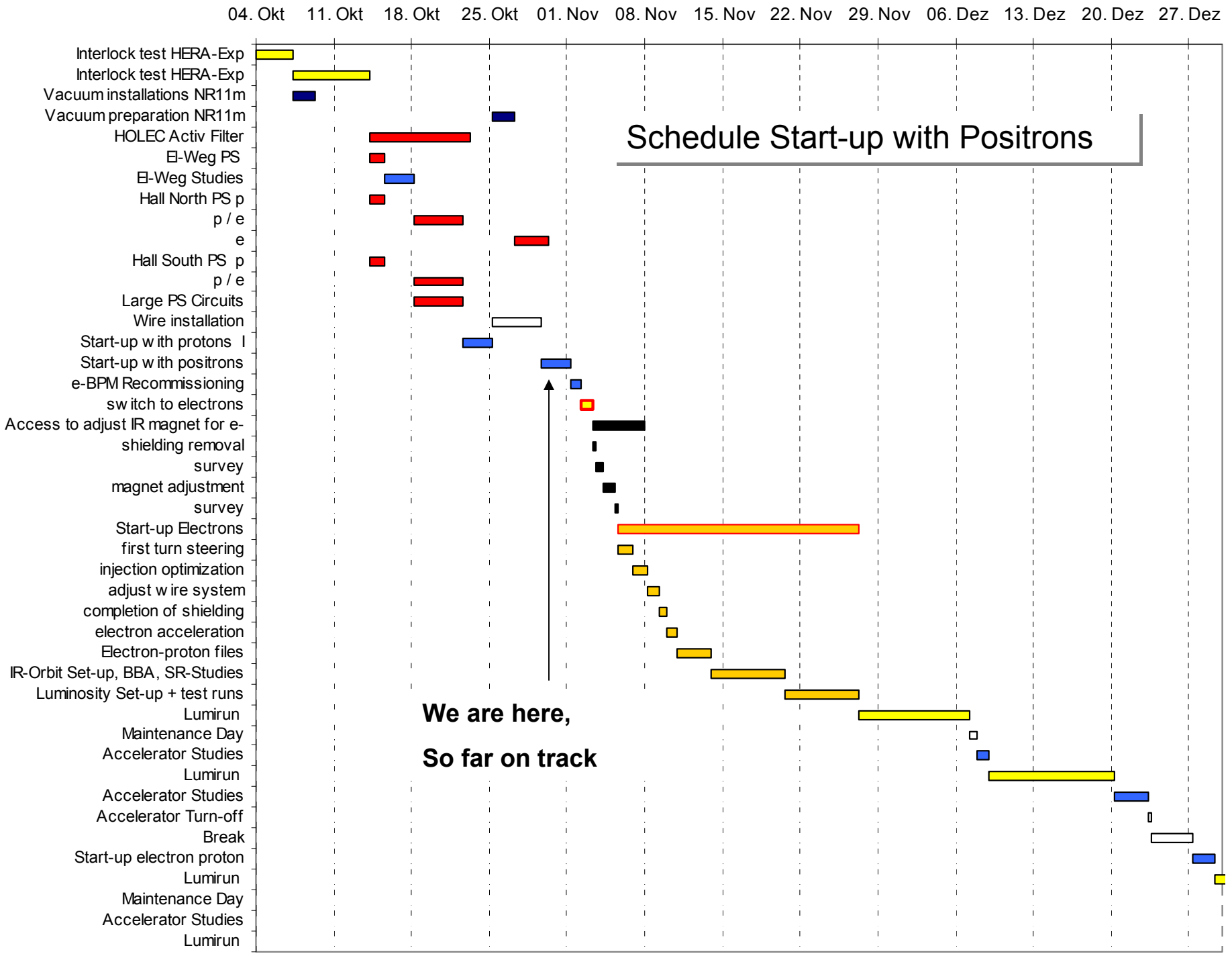
Disadvantage: Tails reach further out





Decision : nominal Solution

F.Willeke: HERA, 58th PRC


Schedule Start-up with Positrons
04. Okt
11. Okt
18. Okt
25. Okt
01. Nov
08. Nov
15. Nov
22. Nov
29. Nov
06. Dez
13. Dez
20. Dez
27. Dez
Interlock test HERA-Exp
Interlock test HERA-Exp
Vacuum installations NR11m
Vacuum preparation NR11m
HOLEC Activ Filter
El-Weg PS
El-Weg Studies
Hall North PS p
p / e
e
Hall South PS p
p / e
Large PS Circuits
Wire installation
Start-up w ith protons I
Start-up w ith positrons
e-BPM Recommissioning
sw itch to electrons
Access to adjust IR magnet for e-
shielding removal
survey
magnet adjustment
survey
Start-up Electrons
first turn steering
injection optimization
adjust w ire system
completion of shielding
electron acceleration
Electron-proton files
IR-Orbit Set-up, BBA, SR-Studies
Luminosity Set-up + test runs
Lumirun
Maintenance Day
Accelerator Studies
Lumirun
Accelerator Studies
Accelerator Turn-off
Break
Start-up electron proton
Lumirun
Maintenance Day
Accelerator Studies
Lumirun
We are here,
So far on track

Conclusions

- In 2004, a promising start of the HERA running was accomplished
- The luminosity improved as planned
- Accelerator physics issues are well understood and improvements are underway to overcome short comings
- Longitudinal polarization was delivered routinely
- Background conditions with full intensity has been good in general
- Operational efficiency and the availability of accelerator component is still unsatisfactory
- High intensity operation revealed weakness in the design which has been improved
- The shut down was very actively used for the ongoing improvement program
- HERA operations will continue with electrons in 2004/2005 starting-up very soon